

# Mechanical Equilibrium

## Static and Dynamic Equilibrium

# Mechanical Equilibrium: Review

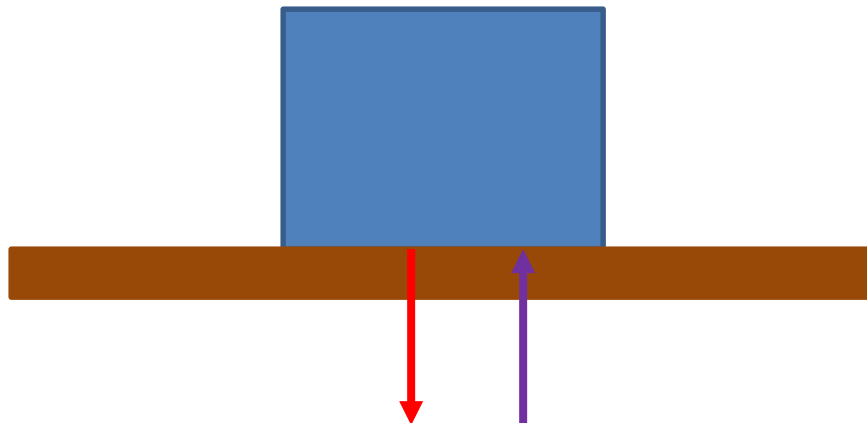
An object in **mechanical equilibrium** is either:

- a) **Not moving** at all = **STATIC equilibrium**
- b) Moving at a **constant velocity** = **DYNAMIC equilibrium**

$$\Sigma F = 0$$

# Static Equilibrium

- Objects do NOT move
- Remember:  
“Positive Forces”: right or up  
“Negative Forces”: left or down



# Dynamic Equilibrium

**Dynamic Equilibrium is slightly more complex....**

- **Friction:**

- Friction: contact between objects that move or sit against each other
- Static Friction:  $F_s = \mu_s N$
- Coefficient of friction ( $\mu_s$ ) depends on:
  - Materials used
  - Temperature
  - Velocity (speed and \_\_\_\_\_ direction \_\_\_\_\_) of objects
- Examples:
  - Metal on Ice:  $\mu_s = 0.03 - 0.05$
  - Wood on Wood:  $\mu_s = 0.30 - 0.70$
  - Aluminum on Aluminum:  $\mu_s = 1.10 - 1.70$

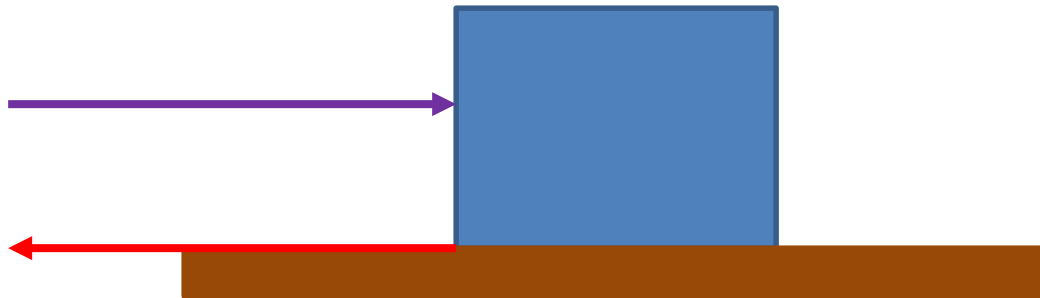
**Bottom Line:**

- The amount of friction between two surfaces depends on the materials of the objects touching!

# Dynamic Equilibrium

More on friction...

If the object is in dynamic equilibrium, the force of friction must be equal in magnitude and opposite in direction to the pushing or pulling force!



# Working Word Problems

When you come across a word problem:

1. **Read** the problem
2. **Underline** the “knowns”
3. **Circle** the “unknowns” (what you want to find)
4. **Draw** a picture and **LABEL**
5. Write the **equations** needed
6. **Solve**
7. **Check**

# Example Mechanical Equilibrium Problem

- Brutus the puppy weighs 132 N. If he has his front paws on one scale and his back paws on another scale (with equal amounts of weight on both scales), what does each scale read?

# Example Equilibrium Problem

An airplane with a weight of 11,000 N cruises at 180 km/h in level flight 2300 m above the ground. How much upward lift force must be acting on the plane? How can you tell?